Correlation of PCB concentration with component content of trophic status in Lake Baikal.

E.N. Tarasova, A.A. Mamontov, E.A. Mamontova, and G.I. Galazy, Institute of Geochemistry, Sibirian Branch of Russian Academy of Sciences, Irkutsk, 664033, Russia

Abstract.

The amounts of PCB concentrations in Lake Baikal's waters, biota and its tributaries as well as in snow cover on the lake's ice have been defined. Analysis of components of the trophic status, at the sites where samples were taken for PCB analysis, was carried out at the same time. PCBs have been found throughout the trophic chain of the lake's ecosystem. A direct dependence between the nitrogen content of the lake's waters and the PCB content in plankton has been found.

Introduction.

Considerable changes in lake Baikal's ecosystem have occurred since 1960: the cyclic development of endemic mass type phytoplankton - Aulocasiera Baicalensis - has been disturbed; the physiological characteristics of Baikal fish have deteriorated and their rate of growth has also fallen[1]; small diatomic algae Achnanthes minutissima have been found at great depth in the lake[2] and, finally, the mass death of seal occurred in 1987.

Systematic investigations into the main components of the ion content and the trophic status in lake waters, its tributaries and atmospheric precepitation have allowed an estimate to be made of the scale of technogenic impact[3]. The inverse correlation between the winter nitrogen content and spring concentration of chlorophyll-a in Baikal's waters at optimum ratio of biogenic components permits one to draw the conclusion as to the presence of toxicants in its water[4].

Experimental Methods

PCBs were determined in the surface water of the lake, its tributaries, effluents of the Baikalsk and Selenginsk pulp and paper mills (BPPM and SPCM), and snow cover, collected near the lake (Fig.1). In additation, in May, 1989 phytoplankton and zooplankton (Fig.2), and a number of fish species (Coregonus autumnalis migratories, Cottocomephorinae, Thymallus arcticus) were collected in different parts of the lake.

PCB determination was carried out, using a Hewlett-Packard chromotograph, model HP-5890 and mass selective detector of the same firm model MD-5970, based on the method of Mitroshkov[5], who indicated the possibility of detecting chlorinated dioxins in hexan extract from water without purification. The carbon, nitrigen, phosphorus and silica content of the water was determined[6].

Results and Discussion

Maximum PCB concentration was defined in zooplankton in May 1989 in Listvenichny bay (5.92 mkg/g) and in phytoplankton near Ushkany islands (6.92 mkg/g). Uneven distribution of PCB content has been observed in other geosystems of the lake. Thus under the winter ice in 1992 in South Baikal waters the PCB concentration varied from 0.04 (in 0.5 km from river Goloustny) up to 0.10 mkg/l (0.2 km from BPPM). In the water of the lake's tributaries under the winter ice the largest concentrations were found in the rivers Utulik (0.12 mkg/l) and Selenga (0.13 mkg/l); the smallest - in the river Goloustny (0.02 mkg/l). In the snow of the lake basin at the beginning of March, 1992, the amount of PCB ranged from 0.05 in the North of Baikal near the river Tompa up to 0.12 mkg/l in the South of the lake near BPPM. In the waste waters of BPPM the concentration of PCBs in March, 1992, was 0.28 mkg/l; in March, 1993, - 0.35 mkg/l; in the waste waters from SPCM - 0.18 mkg/l. The concentration of PCBs in different organs of fish studied ranges from 0.002 up to 0.193 mkg/g.

According to the joint UN and World Health Organization Programme on the environment (1980)[7], fresh water is considered to be non-polluted when the amount of PCBs is no greater than 0.5-5.0 ng/l; average polluted - up to 50 ng/l and highly polluted up to 500 ng/l. Based on this classification, the waters of lake Baikal and its tributaries can be classified as averagely polluted. Selenga and Utulik waters - highly polluted. The same situation is true of the major mass of snow cover samples all over the area of the lake Baikal basin in Russia.

The concentration of PCBs in lake biota depends on the time and place of research. Fairly high amounts of PCBs in plankton have been found in areas of cellulose fibre accumulation. Higher concentrations of PCBs in plankton compared with fish can be explained by the selection of plankton samples in 1989 in a period of a very high level of technogenic impact on the lake, the fish were caught in 1992 in the North of Baikal and Maloye Morye, areas where the impact of BPPM and SPCM are minimal[3].

The dependence of PCB content in plankton on the place it was caught is confirmed by the direct dependence between nitrogen content in water and PCB concentration in plankton (Fig.3). The domination of tetra PCB in waste waters as well as in fish and plankton (Table 1,2) permits one to make the conclusion that the main sources of PCB input into the lake ecosystem are discharges from BPPM, SPCM. The conclusion as to local sources of PCB input into lake Baikal is confirmed by the research of Japanese scientists[8]. The conclusion of Bobovnikova and Dibtseva[9] as to global transfer as the main source of PCBs in lake Baikal explained by these authors as the peculiarity of the lake (low temperature and low water-exchange) contradicts world data, which testify to decreasing PCBs in industrial discharges since the seventies as a result of laws banning or limiting the use of PCBs in many countries.

The results of investigations into PCB content level in different geosystems of Baikal can serve as a base for including these compounds into the programme of chemical monitoring. The direct relationship between the nitrogen content in the lake's water and the concentration of PCBs in plankton will allow for more effective monitoring in the lake.

Table 1. Composition of PCB homologues in plankton of lake Baikal (%).

Sample site	di-	tri-	tetra-	penta-	hexa-
Tolsty-Snezhnaya (middle of section)	11	2	46	27	14
15 km from Kultuk	11	-	7	60	22
3 km from Snezhnaya	42	-	4	30	24
3 km from Vydrino	6	-	38	37	19
1 km from Listvenichny	11	-	22	54	13

2 km from Peschany	1	0,2	77	16	5,8
Hoboi-Barguzin's bay (middle of section)	-	-	-	16	84
3 km from Ushkany islands	23	3	39	27	8
1 km from Bolshiye Koty	11	-	6	11	72

Table 2. The PCB content in fish, 1992, mkg/g*10^{-3}.

Sample site	Organ	di-	tri-	tetra-	penta-	hexa-	octa-
Coregonus autumnalis migratories(Gorgi), Severobaikalsk	muscles ovary buds	0,57 14,0 0,4	6,0 42,0 0,6	26,0 87,0 2,0	9,0 20,0 0,7	4,0 15,0 1,2	2,5 15,0 0,8
Thymallys arcticus baicalensis Dyb., Severobaikalsk	muscules buds	1,1 1,5	16,0 3,8	50,0 13,0	16,0 6,6	14,0 3,2	1,5 2,2
Brachymystax lenok Pallas, Kabanja	on the whole liver gills	0,18 2,0 0,65	0,16 6,0 2,3	0,48 19,0 8,0	2,0 6,6 5,6	1,3 3,0 2,5	0,3 2,6 3,5
Cottoidei grewingki, Severobaikalsk	muscles	8,2	13,0	52,0	20,0	7,5	4,1
Comephorus baikalensis Pall., Listvenichnoe		3,0	5,0	20,0	32,0	33,0	7,0
Comephorus baikalensis Pall., Maloe Morye		2,0	4,0	5,0	20,0	5,0	-

Literature Cited

(1) Galazy, G.I.; Linevich, A.A.; Tarasova, E.N.; Popovskay, G.I.; Afanasjeva E.L. *State and Perspectives of development of methodological basis of chemical and biological monitoring in surface waters of land*. Rostov-on-Don, **1987**, 115-116.

(2) Kozhova, O.M.; Kobanova, G.I. *Estimation of state of water and land ecologycal systems*, Nauka, Novosibirsk, **1994**, 24-29.

(3) Tarasova, E.N.; Mesheryakova, A.I. *Modern state of hydrochemical regime of lake Baikal*, Nauka, Novosibirsk, **1992**, 144 pages.

(4) Galazy, G.I.; Tarasova, E.N. *Estimation of state of water and land ecologycal systems*, Nauka, Novosibirsk, **1994**, p/ 17-24.

(5) Mitroshkov, A.V.; Kiruhin, V.P.; Rahmanova, G.V.*Trudi IEM*, Moscow, **1990**, 17 (145), 128-139.

(6) Strickland, J.D.; Parsons, T.R. *A practical hanbook of sea water analysis*, Ottawa, **1968**, 360.

(7) Polychlorinated biphenyls and terphenyls. WHO Geneva; Medivcine, **1980**, 98

(8) Iwata, H.; Tannabe, S.; Nakata, H.; Tatzukava, R.; Amano, M.; Myasaki, N.; Petrov, E. *Baikal - natural laboratory for researching the change of environment and climate*. 3, Irkutsk, **1994**, 35-36.

(9) Bobovnikova, C.I.; Dibtseva, A.V. *Baikal - natural laboratory for researching the change of environment and climate*, 3, Irkutsk, **1994**, 16-17.

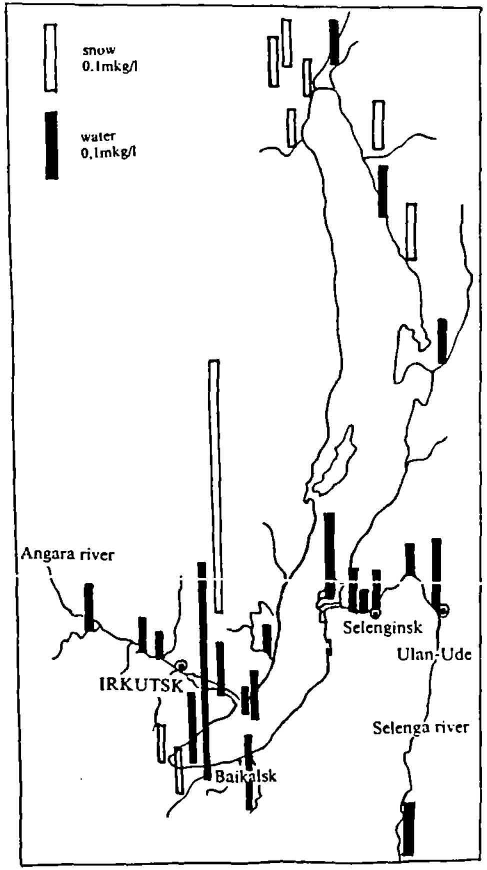

Fig.1: Sampling scheme and PCB content in water of Lake Baikal, its tributaries and snow cover of the lake basin. February - March.

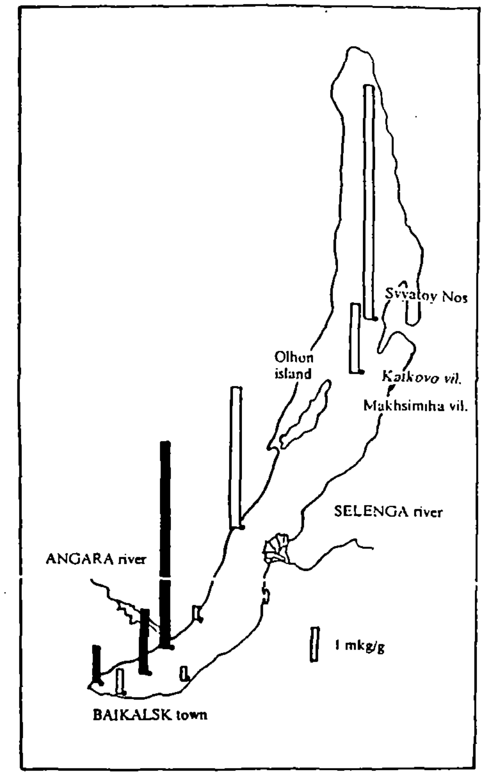

Fig. 2 Sampling scheme and PCB concentration in phyto(▯) and zooplankton (▮) of Lake Baikal.

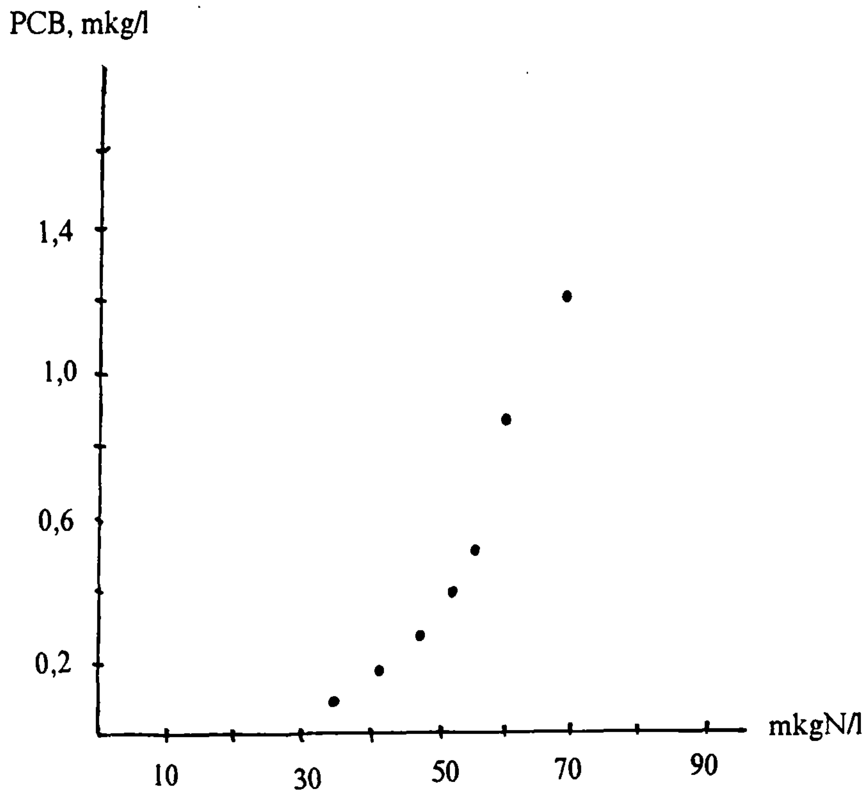

Fig.3: Dependence between PCB concentration in lake plankton and nitrogen content in Baikal water.